FABRICATION OF ULTRANANOCRYSTALLINE DIAMOND ATOMIC FORCE MICROSCOPE PROBES

Guoqing Ning, A.V. Sumant, D. S. Grierson, and R. W. Carpick

Department of Engineering Physics, University of Wisconsin-Madison, Madison, WI53706

J.E.Gerbi, J. Birrell, X. Xiao, Orlando Auciello, John A. Carlisle

Materials Science Division, Argonne National Laboratory, Argonne, IL

Keywords: Atomic force microscope; Ultranonocrystalline diamond; AFM probes

Abstract

Minimizing wear on tips used in the atomic force microscope is a critical problem in scanning probe microscopy. Diamond is an ideal candidate material for such tips because of its outstanding mechanical, chemical and tribological properties. However, it is very difficult to fabricate atomically sharp diamond tips with the conventional chemical vapor deposition (CVD)-diamond technology because of the intrinsically large grain size (micrometers). Ultrananocrystalline diamond (UNCD) is an ideal candidate material for such application because of the small grain size (3-5 nm) with extremely low surface roughness (~11 nm) and the ability to form conformal ultra-thin coatings (less than 100 nm thick). Here we describe a fabrication process to batch-fabricate monolithic ultranonocrystalline diamond (UNCD) AFM probes. Detailed steps include fabricating pyramidal etch pits on the silicon wafer by anisotropic etching of Si in KOH followed by UNCD deposition (~1μm). The UNCD-coated wafer is then subjected to a series of fabrication steps including metallization, photolithography, and RIE to from monolithic UNCD cantilevers with integrated pyramidal tips. These cantilevers are finally released from the backside and then physically bonded to the holding substrate and then sawed with dicing saw to take out individually for testing. Here we present the fabrication part to demonstrate that monolithic UNCD cantilevers can be fabricated using fabrication approach we have developed in our laboratory.

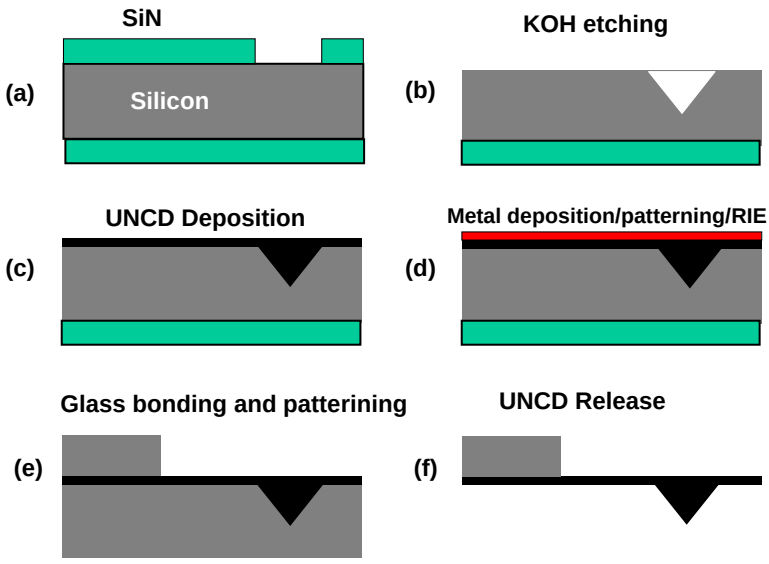

Figure1. Fabrication process flow for the UNCD probe

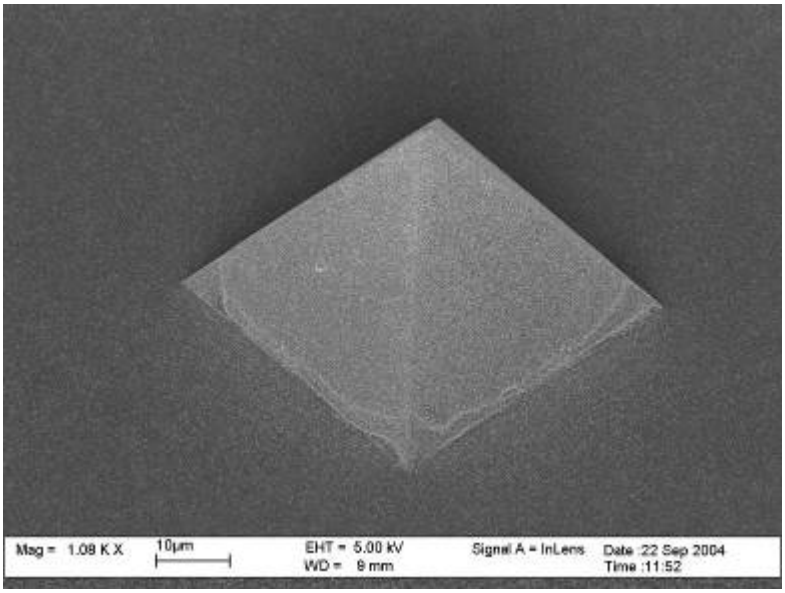

Figure2. SEM image of the UNCD tip fabricated using Si mold technique